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CHARACTERISTICS OF OUTDOOR RECREATIONAL TRAVEL

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INFORMATIVE ABSTRACT

The purpose of this investigation was to examine the characteristics of travel to outdoor recreational areas in Kentucky. Data were obtained by means of a license-plate, origin-destination survey at 160 sites within 42 recreational areas and by means of a continuous vehicle counting program at eight of these sites. A computer algorithm was developed for error detection and subsequent adjustment of the volume data as necessitated by occasional malfunction of the traffic recorders and vandalism. Vehicle occupancy was found to depend of the type of recreational area, distance traveled, and vehicle type. Occupancy increased with increasing distance and was greatest for those vehicles pulling camping trailers. Percentages of the various vehicle types were also influenced by the type of recreational area and the distance traveled. The proportion of camping units in the traffic stream increased with increasing distance of travel. In general, trip lengths were quite short as evidenced by the fact that 60 percent of all vehicles traveled less than 50 miles. However, trip-length distribution was highly dependent of the type and location of the recreational area. Analysis of the distribution of traffic over time verified that recreational travel is much more highly peaked than other forms of highway travel and, with the exception of holidays, is concentrated on Sundays during the spring and summer months. This time period appears most appropriate for the design of highways and parking facilities to serve recreational areas. It is highly recommended that future data collection programs be concentrated on the average summer Sunday to enable collection of the maximum amount of usable traffic data with a minimum of effort. Much of the data reported herein can be used in initial efforts to characterize travel to similar types of recreational areas outside of Kentucky.

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INTRODUCTION

In 1970, the Kentucky Department of Highways initiated a study to examine the characteristics of travel to outdoor recreational areas in Kentucky and to develop a model for simulating these flows. Results of the modeling efforts have been reported elsewhere *(3, 6)*. The purpose of this paper is to describe many of the characteristics of recreational travel that are of interest to highway engineers including vehicle occupancy, vehicle type, trip-length distribution, and the distribution of flows over time. Knowledge of these characteristics is necessary for the efficient design of highways and parking facilities to accommodate recreational travel.

SELECTION OF RECREATIONAL AREAS

A total of 42 recreational areas, encompassing a major part of outdoor recreational activity in Kentucky, were chosen for detailed study. These areas, identified in Table 1, represent (1) a variety of facility types from small fishing lakes to major scenic attractions, (2) a broad geographic distribution within the state, and (3) a wide variety of operating agencies.

Characteristics of the 42 areas are also summarized in Table 1. That characteristic termed "regional impact" was evaluated from two measures of travel obtained from an origin-destination (O-D) survey -- the coefficient of variation of the actual number of trips produced by 190 origin zones located throughout the United States and the percentage of trips having lengths greater than 50 miles. Coefficients of variation for those areas having large (L), medium (M), and small (S) regional impact averaged 280, 480, and 720 percent, respectively. Corresponding average percentages of trips having lengths greater than 50 miles were 66.7, 35.7, and 23.7 percent, respectively.

DATA ACQUISITION

Two surveys were undertaken to provide data for characterizing outdoor recreational travel. One, a traffic volume survey, provided data concerning the fluctuations of traffic volumes over time. The other, an O-D survey, provided information on vehicle occupancies, vehicle types, trip lengths, etc.

Traffic volume data were obtained from continuous automatic traffic recorders located at eight sites (indicated by asterisks in Table 1) considered to be most representative of Kentucky outdoor recreational areas. The punched-tape counters, employing inductive loops for vehicle detection, recorded two-way flows continuously from July 1970 through June 1971. In each case, the recorder was located on a major access road to the recreational area in such a manner as to intercept only recreational-oriented travel. A total of 3,039,403 vehicles were counted at the eight sites during the one-year survey. This represented an average of about 380,000 vehicles annually per site.

The license-plate, O-D survey was conducted at 160 sites, similarly located to intercept only recreational-oriented travel, during the summer of 1970. Each of these sites was associated with one of the 42 recreational areas. The sites were carefully selected so that the sum of the flows passing all the sites associated with a given recreational area accurately represented the total flow to that area. The O-D survey at each site was conducted during a 10-hour period of normal peak flow, namely 10 a.m. to 8 p.m. on summer Sundays. No data were collected during holiday weekends. Recorded for each observed vehicle were the direction of movement (arriving or departing), vehicle type, vehicle occupancy, and license-plate identification. The license-plate identification was used to approximate the zone of origin of the vehicle.

A total of 130,653 vehicles were observed as a part of the O-D survey. Considering those small intervals during each 10-hour period when the surveyors were otherwise occupied, it was estimated that a total of 147,000 vehicles actually passed the 160 sites during the survey period. A further adjustment was made to account for the few instances in which inclement weather prevailed, bringing the total estimated flow to 151,300 vehicles.

TRIP ORIGINS

Of the vehicles observed in the O-D survey, approximately 73.0 percent were licensed in Kentucky. This percentage was sensitive to the type of recreational area, however, and varied from a low of 36.6 percent at the two national parks (Mammoth Cave and Cumberland Gap) to a high of 85.2 percent at Corps-of-Engineers-administered facilities which are predominantly day-use oriented. Table 2 indicates the percentages of vehicles from different origins as a function of facility type. The origins are arranged in Table 2 in approximate order of increasing distance from Kentucky. The effect of geographic proximity is most pronounced. It was also found that about 96.3 percent of all vehicles came from Kentucky and seven nearby states including, in order of highest to lowest visitation, Ohio, Indiana, Illinois, Tennessee, Michigan, Missouri, and West Virginia.

VEHICLE OCCUPANCY

The O-D survey provided information with which to evaluate average vehicle occupancy, that is, the average number of persons in each vehicle. The average occupancy rate for all vehicles was found to be 3.06 persons per vehicle. However, occupancy rate was a function of the type of recreational area, distance traveled, and vehicle type.

Table 3 demonstrates the effect of recreational-area type on average vehicle occupancy. Lowest occupancy rates of 2.87 to 2.88 persons per vehicle occurred at predominantly day-use, water-oriented facilities; intermediate rates of 3.13 to 3.26 persons per vehicle occurred at multiple-use facilities; and the highest rates of 3.36 to 3.41 persons per vehicle occurred at scenic areas catering to families and having nationwide interest.

Table 3 also indicates that location of origin affects vehicle occupancy. The average occupancy rate for Kentucky vehicles was 2.94 persons per vehicle and that for the seven primary states outside of Kentucky was 3.41 persons per vehicle. This suggests that occupancy rates may be related to distance traveled, a hypothesis that seems plausible considering that many out-of-state vehicles contain vacationing families.

Table 4 illustrates the effects of both distance and vehicle type on occupancy rate. Despite large variability in the data, occupancy rate generally increased with increasing distance of travel. The effects were most pronounced for vehicles traveling rather short distances. In addition, sensitivity of occupancy rate to distance was greatest for camping vehicles and least for vehicles with boats.

Highest occupancy rates were observed for cars pulling camper trailers, and lowest rates were observed for the "other" vehicle category which includes primarily service trucks and motorcycles. The fact that single-unit campers had much lower occupancy rates than cars pulling camper trailers is probably due to a combination of (1) erroneous surveys in which some persons riding in the single-unit campers could not be detected by the surveyors and (2) a certain bias caused by rather extensive use of pickup campers by fishermen who usually travel in small groups.

Considerable variation is found in occupancy rates reported by others. To illustrate, an average occupancy rate of 3.2 persons per vehicle has been reported for weekend recreational travel in Kansas *(4)*. Occupancy rates for recreational travel in Arkansas averaged 3.3 persons per vehicle for Arkansas residents and 3.2 persons per vehicle for out-of-state residents *(1)*. Analysis of weekend travel to ten Kansas reservoirs yielded average occupancy rates ranging from 3.3 to 4.2 persons per vehicle *(7)*. The Kansas data also showed that occupancy rate was affected by trip purpose. Finally, an average occupancy rate of 3.7 persons per vehicle was observed at three parks in Indiana *(5)*. The above data together with that reported herein substantiate the observation that average occupancy rate for outdoor recreational travel is considerably larger than for other highway travel.

VEHICLE TYPES

As anticipated, a large proportion of the vehicles were cars (pickups included) and cars pulling trailers (a total of 96.7 percent). The remainder were single-unit campers (2.1 percent) and motorcycles, trucks, and buses (1.2 percent). Altogether, 3.4 percent of the vehicles had camping units attached and 5.8 percent had boats. Vehicle classification was found to depend on both trip origin and type of recreational area.

To illustrate the effect of origin, 2.1 percent of the Kentucky vehicles had camping units and 6.0 percent had boats; respective percentages for Michigan vehicles were 10.4 percent and 3.9 percent. These and similar data are summarized for the eight primary states contributing to Kentucky recreational travel in Table 5. Origin effects are due in large part to intervening distances (Figure 1). Decreasing percentage of cars with increasing distance reflected the increasingly greater use of single-unit campers over the longer distances. As distance increased, a greater percentage of recreationists used camping vehicles. Boat usage peaked in the distance range of 60 to 90 miles.

The effects of recreational-facility type on vehicle usage are quite clear. A high percentage of vehicles with boats were observed at water-based facilities (a high of 12.3 percent at Corps of Engineers facilities compared to a low of 0.6 percent at national parks). The percentage of vehicles with camping units depended in large part on the nature of available camping facilities (a high of 11.2 percent at Land-between-the-Lakes compared to a low of 3.0 percent at state parks). Table 6 summarizes these data.

TRIP-LENGTH DISTRIBUTION

Examination of trip origins, as summarized in Table 2, revealed that most recreationists came from Kentucky. This suggested that travel to Kentucky outdoor recreational facilities was predominantly of the short-distance type. The average trip length for all vehicles was found to be 109 miles. However, 60 percent of all vehicles traveled distances less than 50 miles and the 72 percent traveled less than 100 miles. Ungar *(8)* also showed that outdoor recreational travel is predominantly of the short-distance type. He reported that 50 percent of the recreationists in Indiana traveled distances less than 50 miles and in Kansas, less than 40 miles. The corresponding distance for travel in Kentucky was found to be 38 miles.

Trip lengths were found to be a function of the type and location of the recreational area. Figure 2 shows trip-length distributions for three state parks representative of large regional impact areas (Cumberland Falls), medium regional impact areas (My Old Kentucky Home), and small regional impact areas (Jenny Wiley). Mean trip lengths for those areas classified in Table 1 as having large, medium, and small regional impact averaged 176, 89, and 70 miles, respectively. Corresponding average percentages of trips having lengths less than 50 miles were 33.3, 64.3, and 76.3 percent, respectively.

Also of considerable interest is the influence of vehicle type on the distribution of trip lengths (Figure 3). Cars pulling camper trailers generally traveled the greatest distances. Single-unit campers traveled somewhat shorter distances due in part to the considerable use of single-unit campers by fishermen. Cars without either boats or trailers generally traveled the shortest distances of any vehicle type.

VOLUME ADJUSTMENTS

Because of vandalism and equipment malfunction, a limited amount of traffic volume data from each of the eight continuous recorders was found to be in error. This necessitated development of computer routines for error detection and subsequent adjustment of erroneous data. These routines were based on the premises (1) that hourly volumes at a given location for a particular hour of the day and a particular day of the week should demonstrate a great deal of consistency throughout the year and (2) that such volumes should reach a minimum in the winter months and a maximum in the spring or summer months. All hourly volume data for a given site were therefore rearranged into 168 groups of 52 volumes each. Each group represented a particular hour of a particular day and was analyzed independently of other groups. Each of the 52 hourly volumes corresponded to a particular week of the year. Figure 4 is a plot of one such group of data taken at Levi Jackson State Park.

Error detection proceeded as follows. Let V_i represent the hourly volume corresponding to the ith week and AV represent the average of the 52 hourly volumes. First, grossly inaccurate data were identified when either of the following two sets of inequalities were satisfied:

$$V_i < 0.05 \text{ AV and } \left| V_i - \text{AV} \right| > 80 \qquad (1)$$

or

$$V_i > 6.0 \text{ AV and } \left| V_i - \text{AV} \right| > 80. \qquad (2)$$

Erroneous data so identified were automatically removed from the data set and 7-item moving averages (MAV_i) were calculated. The second comparisons to detect erroneous data were based on the following two sets of inequalities which compared each hourly volume with the corresponding moving average:

$$V_i < 0.2 \text{ MAV}_i \text{ and } \left| V_i - \text{MAV}_i \right| > 20 \qquad (3)$$

or

$$V_i > 2.0 \text{ MAV}_i \text{ and } \left| V_i - \text{MAV}_i \right| > 20. \qquad (4)$$

Figure 4 shows, for the group of data at Levi Jackson State Park, four erroneous volumes detected in this way.

Having identified the set of "correct" data, it was necessary to provide more reasonable estimates of the "incorrect" data. This was accomplished by fitting a third-degree polynomial to the correct data and obtaining the desired estimates by interpolation. Figure 4 also shows such a polynomial which was used to make the required four estimates for this group of data.

The aforedescribed procedure for error detection and correction was found to be invaluable to this study even though there was some risk that all erroneous data were not detected and some smaller risk that some correct data were detected as being erroneous. Altogether, eight percent of the hourly volumes were found to be in error. This includes data from two locations at which the recorders were known to be inoperative for a cumulative total at each of approximately two months. Identical procedures for error detection and correction can be used for other types of hourly volume data collected on an annual basis if suitable modifications are made to the limiting constants in the above inequalities.

TIME DISTRIBUTION OF FLOWS

The distribution of recreational traffic volumes over time can be examined in various ways. Data from this study are presented in following sections (1) to show average and certain highest volumes for different time periods, (2) to demonstrate cyclic patterns throughout the year, and (3) to enable short-term counts of recreational traffic to be expanded into estimates of certain average flows.

In analyzing these data, a weekend was defined to encompass the 48-hour period from 6 p.m. on Friday to 6 p.m. on Sunday. Seasons were specifically defined as follows: summer -- June 20 through September 19, fall -- September 20 through December 19, winter -- December 20 through March 19, and spring -- March 20 through June 19. Average daily traffic (ADT) was defined in the conventional manner as the total annual volume divided by 365. Various summer averages were computed in such a manner as to exclude the summer holidays of Labor Day and July 4.

AVERAGE AND HIGHEST VOLUMES

Hourly volumes, expressed as a percentage of ADT, for the 200 highest-volume hours of the year are presented in Figure 5. Three curves are shown on this and subsequent figures. The upper curve represents the maximum volumes at any of the eight sites, the middle curve represents the eight-site average volumes, and the lower curve represents the minimum volumes at any of the sites. The maximum hourly volume as a percentage of ADT varied from a high of 121.2 percent at Boonesboro to a low of 37.2 percent at Mammoth Cave and averaged 63.2 percent at the eight sites. The 30th highest hourly volumes ranged from a high of 82.9 percent of the ADT at Boonesboro to a low of 24.0 percent at Beaver Lake and averaged 38.8 percent at the eight sites [1]. As anticipated, the 30th highest hourly

[1] Maring has reported 30th highest hourly volumes ranging from 14.5 to 22.3 percent of the ADT *(4)*. However, the locations at which his data were obtained intercepted some travel not specifically destined to outdoor recreational areas.

percentages were considerably greater than those commonly observed for normal urban or rural travel indicating the peaking commonly associated with recreational travel. The highest peaking was observed at Fort Boonesboro State Park, a predominantly day-use facility attracting significant numbers of visitors only during the summer months. Lowest peaking was observed at Mammoth Cave National Park, a scenic attraction of national importance, and Beaver Lake, a small fishing lake attracting fishermen during the spring, summer and fall months.

In general, the highest-volume hours occurred on Sundays. Approximately 83 percent of the 100 highest-volume hours occurred on Sundays and approximately 10 percent occurred on Saturdays. The only major exception among the eight sites was at Mammoth Cave where only 38 percent of the 100 highest-volume hours occurred on Sundays; the remainder were approximately equally divided among Tuesdays, Wednesdays, and Saturdays.

Daily volumes, expressed as a multiple of ADT, for the 100 highest-volume days are shown in Figure 6. The maximum daily volume ranged from a high of 889 percent of the ADT at Boonesboro to a low of 332 percent at Beaver Lake. Matthias and Grecco *(5)* have reported maximum daily volumes at three parks in Indiana averaging approximately 1350 percent of the ADT. These data clearly demonstrate the significant daily peaking associated with recreational traffic. The high-volume days of Figure 6 were typically associated with summer Sundays. Average summer Sunday volumes ranged from a high of 412 percent of the ADT at Boonesboro to a low of 156 percent of the ADT at Beaver Lake. In general, the average summer Sunday volumes corresponded with that volume associated with the 11th or 12th highest-volume day.

Finally, Figure 7 shows the weekly volumes arranged in order of magnitude for the 52 weeks. A very wide range in weekly volumes is shown by this figure. The average summer weekly volumes ranged from a high of 1300 percent of the ADT at Mammoth Cave to a low of 800 percent of the ADT at Beaver Lake. On the whole, the average summer weekly volume corresponded with that volume associated with the 10th highest-volume week.

A summary of these and other pertinent volume data is contained in Table 7. In view of the extreme peaking associated with recreational travel, it seems impractical to design highways serving recreational areas to accomodate the 30th highest hourly volumes. A more practical basis for design would be the peak-hour volume on the average summer Sunday, which on the average corresponds with the 70th to 75th highest hourly volume. Concentration on the average summer Sunday should also greatly facilitate future data collection programs.

CYCLIC PATTERNS

The cyclic nature of recreational travel is also a matter of interest to recreational and highway planners alike. Figures 8 and 9 show the patterns of variation in volumes among seasons and months, respectively, and Table 8 summarizes the peak volumes for the individual recreational areas. As anticipated, seasonal peaks occurred either in the spring or summer. Peak seasonal volume ranged from a low of 36 percent of the total annual volume at Beaver Lake to a high of 46 percent at Mammoth Cave and averaged about 40.6 percent at the eight areas. Others have reported similar seasonal peaking. For example, summer visitation, expressed as a percentage of annual visitation, has been reported to be 40 percent at Tennessee and Kentucky reservoirs *(2)*, 62.1 percent at Indiana and Ohio reservoirs *(2)*, and 45.2 percent for several types of recreational areas in Arkansas *(1)*. The difference between the Tennessee and Kentucky reservoir data and the Indiana and Ohio reservoir data may be due in part to climatic influences which, for travel to reservoirs, cause more peaking during the summer months in the colder areas. Data from Arkansas *(1)* also showed an influence of facility type with seasonal peaks varying from a low of 36.3 percent at national parks to a high of 48.8 percent at Corps of Engineers reservoirs.

Monthly peaks at the individual areas occurred in either May, June, or August. May peaking at Beaver Lake and Lake Barkley is probably attributable to large spring fishing activity. The peak monthly volume, expressed as a percentage of total annual volume, ranged from a low of about 15 percent at Beaver Lake to a high of about 24 percent at Boonesboro and averaged 17.6 percent at the eight areas. Others have likewise reported similar monthly peaking. For example, monthly visitation, expressed as a percentage of annual visitation, has been reported to be 14 percent at Tennessee and Kentucky reservoirs *(2)*, 24.1 percent at Indiana and Ohio reservoirs *(2)*, and 16.7 percent for several types of recreational areas in Arkansas *(1)*. The Arkansas study also demonstrated an influence of facility type with a low monthly peaking of 12.9 percent at national parks to a high of 19.0 percent at Corps of Engineers reservoirs.

Summer daily and hourly cyclic patterns were also investigated. Figure 10 and Table 8 show that peak summer flows occurred on Sundays at all recreational areas. The next highest volume day was Saturday with very little differences among the remaining days of the week. This was somewhat surprising in that it had been anticipated that Friday flows would generally exceed those of other weekdays. On the average, 25 percent of the travel during the typical summer week occurred on Sundays. Smith and Landman also observed notable Sunday peaking in travel to reservoirs in Kansas and, with one exception, reported summer Sunday flows which ranged between 26.5 and 39.0 percent of the corresponding weekly flows *(7)*.

Peaking within the days of summer weekends is demonstrated by Figure 11 and Table 9. The hour of peak flow was typically later on Friday than it was on Saturday; in turn, Saturday peaks occurred later in the day than Sunday peaks. At the same time, Sunday flows were typically more peaked than either Saturday or Friday flows.

EXPANSION FACTORS FOR SHORT-TERM COUNTS

It is frequently desirable to estimate average traffic volumes based on short-term volume surveys. Table 10 contains a set of factors by which short-term counts taken under normal conditions during the summer months can be used to estimate average daily traffic and average summer Sunday traffic. This table, as developed from a complete year of actual data, should prove to be a useful tool for making these conversions. However, the factors vary a great deal among the recreational areas and their effective use relies on careful study and informed judgement.

SUMMARY AND CONCLUSIONS

The purpose of this study was to examine characteristics of travel to outdoor recreational areas in Kentucky that are of interest to the highway engineer. Recreational travel, like many other types of travel, is highly complex and very much dependent upon local conditions. Therefore, much of the specific data assembled herein is sensitive to the nature of the recreational area and its location relative to the various origin zones throughout the United States. Some of the principal findings and conclusions of the study follow.

1. Vehicle occupancy, which averaged 3.06 persons per vehicle, is much larger for outdoor recreational travel than for normal highway travel. Occupancy was found to be a function of the type of recreation area, distance traveled, and vehicle type. Smallest rates were observed at areas having large day-use activity. Among the various vehicle types, occupancy was largest for cars pulling camping trailers. The sensitivity of occupancy rate to distance traveled was greatest for camping vehicles. However, for all vehicle types, occupancy rate increased with increasing distance traveled.

2. A large proportion of the vehicles were cars (96.7 percent). The remainder were single-unit campers (2.1 percent) and motorcycles, trucks, and buses (1.2 percent). Altogether, 3.4 percent of the vehicles had camping units attached and 5.8 percent had boats. The nature of the recreational facilities had a decided impact on the proportion of camping units and boats. The proportion of camping units also increased significantly as distance of travel increased. Boat usage peaked in the distance range of 60 to 90 miles.

3. Trips to outdoor recreational areas of the type found in Kentucky are relatively short as evidenced by the fact that 60 percent of all vehicles traveled less than 50 miles. Trip lengths were definitely dependent upon the type and location of the recreational area, however, and for areas having a large regional impact, average trip length can be quite large. Vehicles with camping units travel on the average much longer distances than other types of vehicles.

4. To investigate the distribution of recreational travel over time, it is highly desirable to conduct long-term, continuous volume surveys. A very effective method was developed and applied herein for the detection and correction of erroneous data collected from the long-term operation of continuous traffic recorders. With minor modifications, this method should prove useful in all long-term, continuous vehicle counting programs.

5. The distribution of recreational traffic over time is highly dependent on the nature of the recreational area, the nature of the recreationists, and the location of the areas in relation to population centers. In any case, however, recreational travel is much more variable over time than other forms of highway travel. Evidence and documentation of this peaking is presented in terms of highest-hourly-volume, highest-daily-volume, and highest-weekly-volume plots.

6. The maximum hourly volumes averaged 63.2 percent of the average daily traffic (ADT) while the 30th highest hourly volumes averaged 38.8 percent of the ADT. Design of highway facilities serving recreational travel to accommodate the 30th highest hourly volume appears in many cases to be impractical. A more practical basis for design is the peak-hour volume on the average summer Sunday. This volume on the average corresponded with the 70th to 75th highest hourly volume. It should be emphasized, however, that proper selection of a design hour volume is a complex task including economic analyses and, of necessity, must vary from situation to situation. Volumes during the summer week averaged 1080 percent of the ADT, those during the summer weekend averaged 480 percent, and those on summer Sundays averaged 270 percent.

7. Cyclic volume variations for the seasons of the year, months of the year, days of the summer week, and hours of the summer weekend are documented herein. The peak seasonal volume averaged 40.6 percent of the total annual volume and occurred in either the spring or summer seasons. The peak monthly volume averaged 17.6 percent of the total annual volume and occurred in either May, June, or August. Sunday was always the peak day of the summer week except for holidays and, on the average, 25 percent of the weekly volume was observed on Sunday. The peak hourly volume on Sundays occurred within the interval of 1 to 5 p.m. and averaged 11 percent of the 24-hour Sunday flows.

8. It is practical to estimate ADT and average summer Sunday traffic from the results of short-term counting programs. Factors that permit such estimates have been documented herein.

ACKNOWLEDGEMENTS

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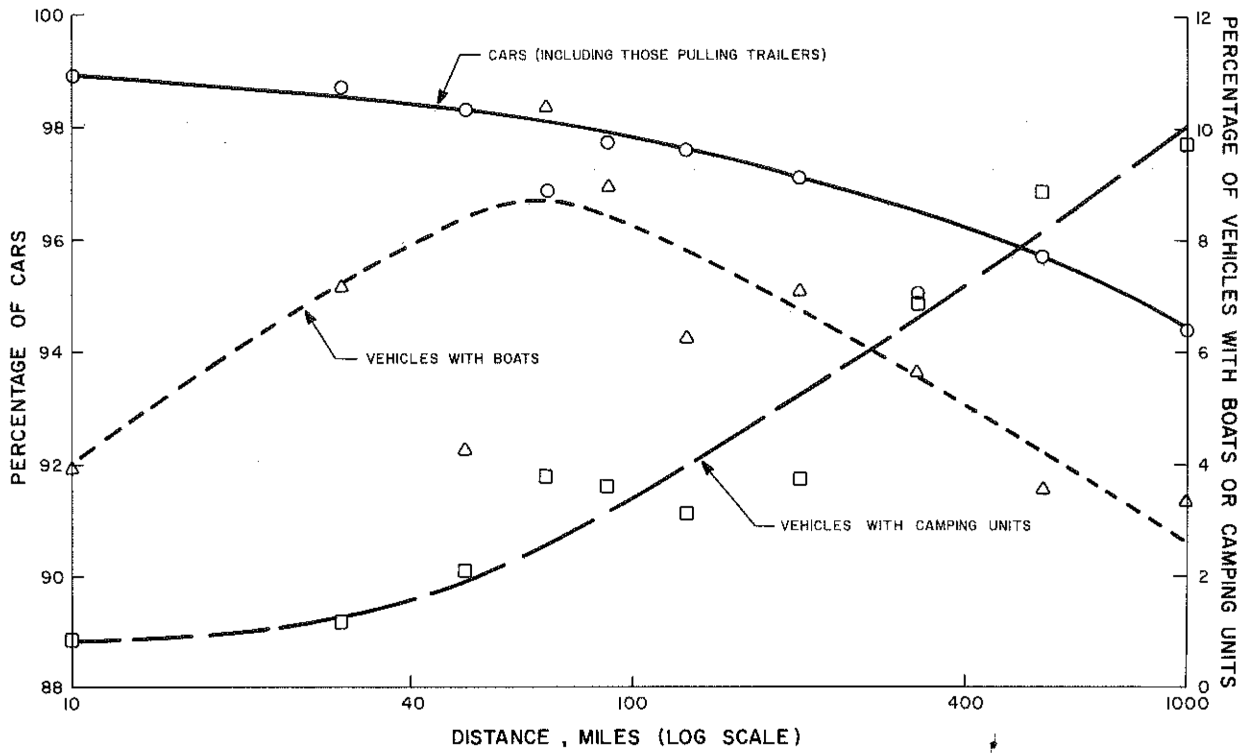

Figure 1. Effect of Distance on Percentages of Various Vehicle Types.

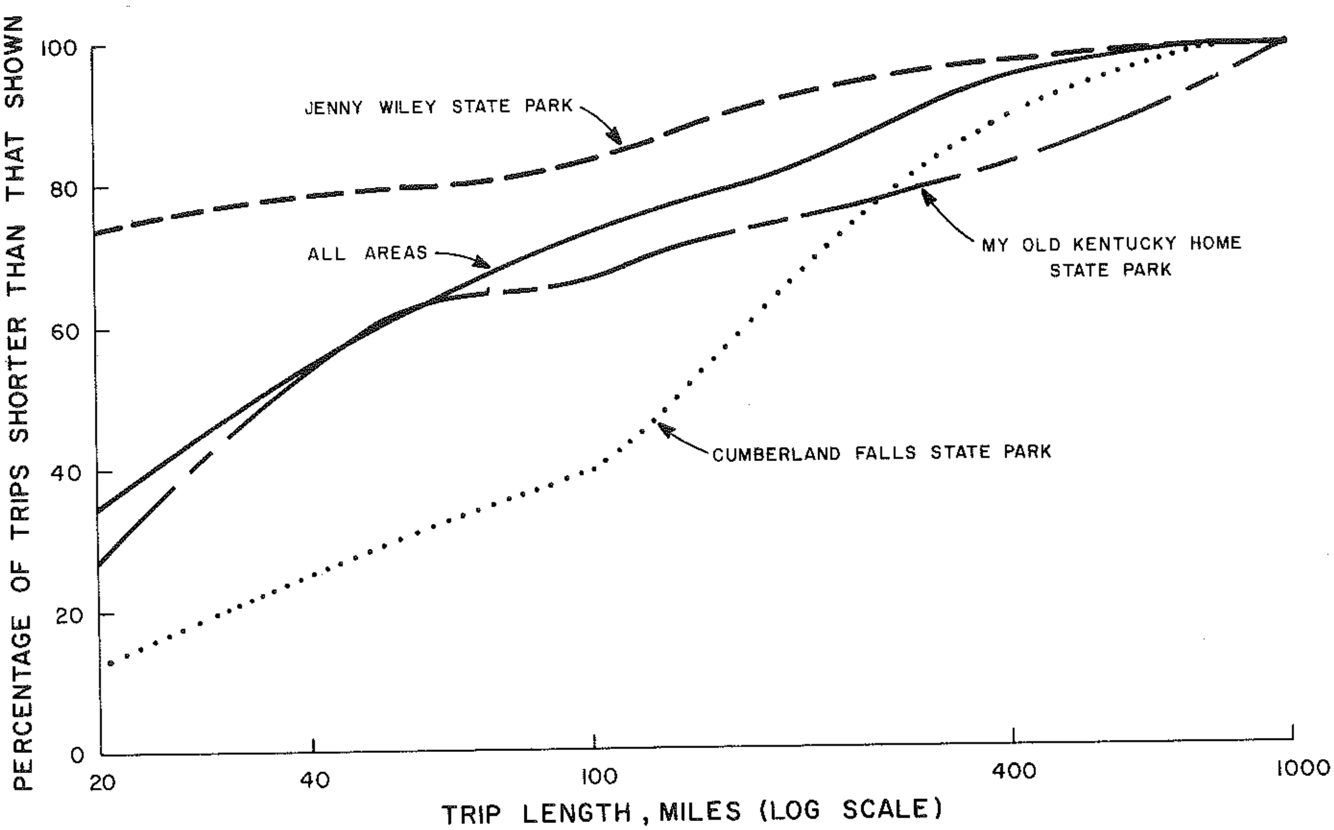

Figure 2. Trip Length Distributions for Different Recreational Areas.

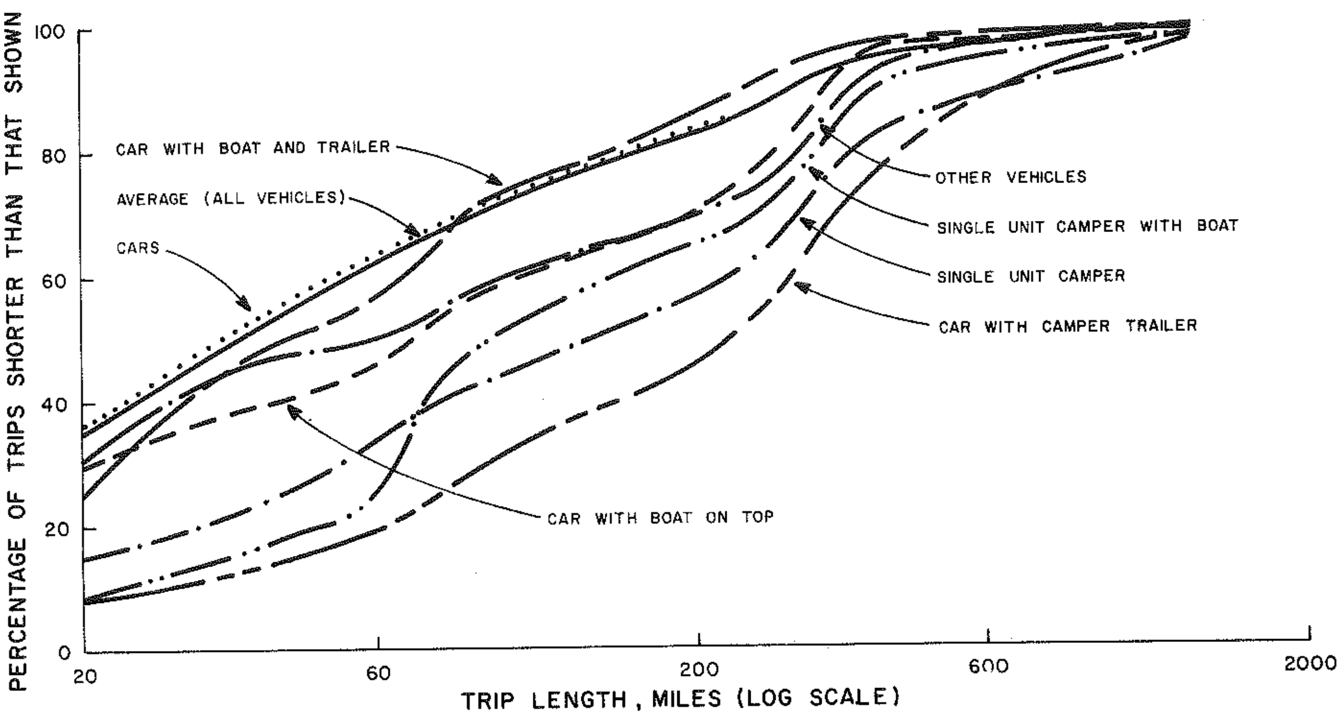

Figure 3. Trip Length Distribution for Different Vehicle Types.

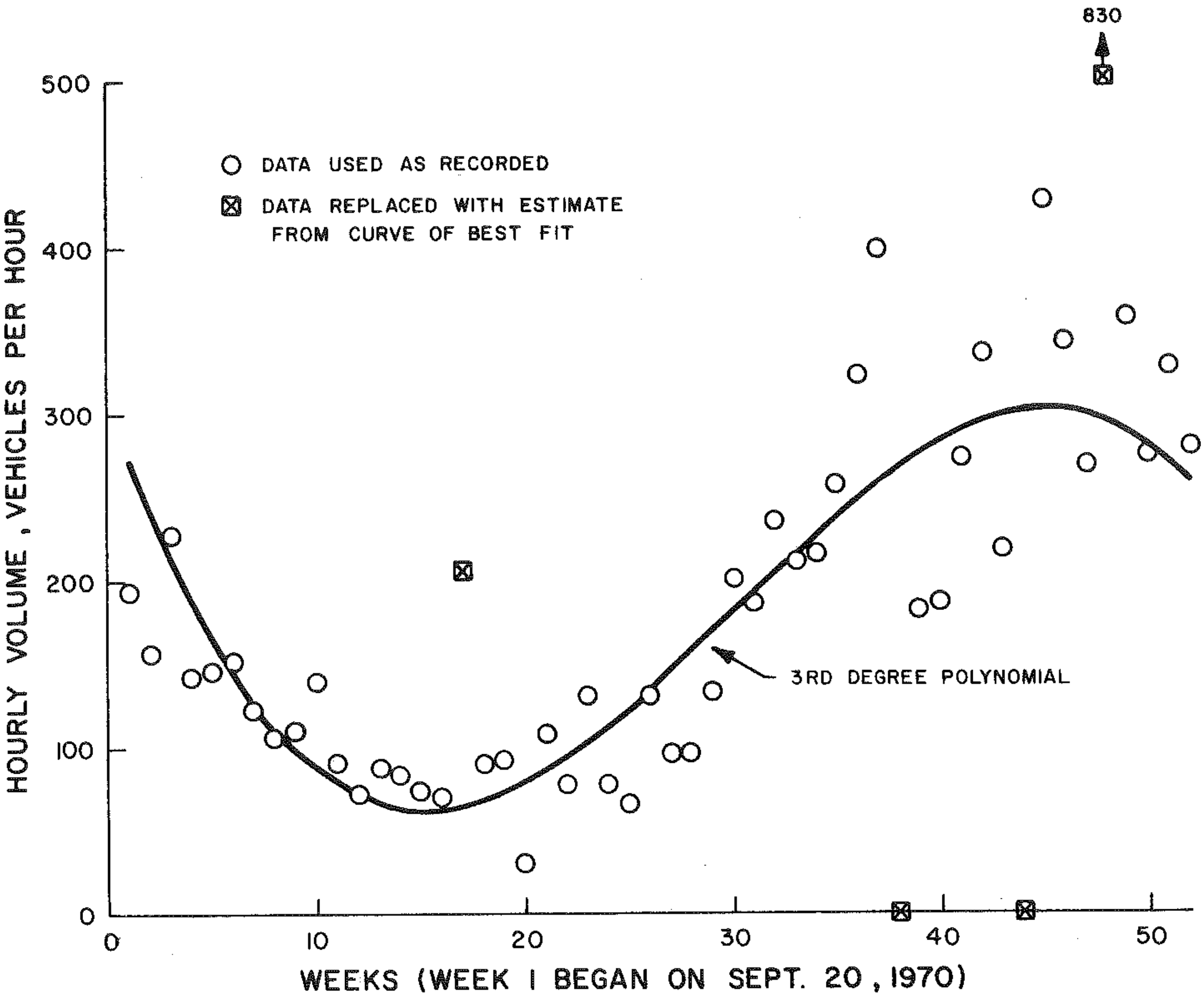

Figure 4. Fluctuation of Hourly Volumes Throughout the Year for the Hour of 12 noon - 1 p.m. on Sundays at Levi Jackson State Park.

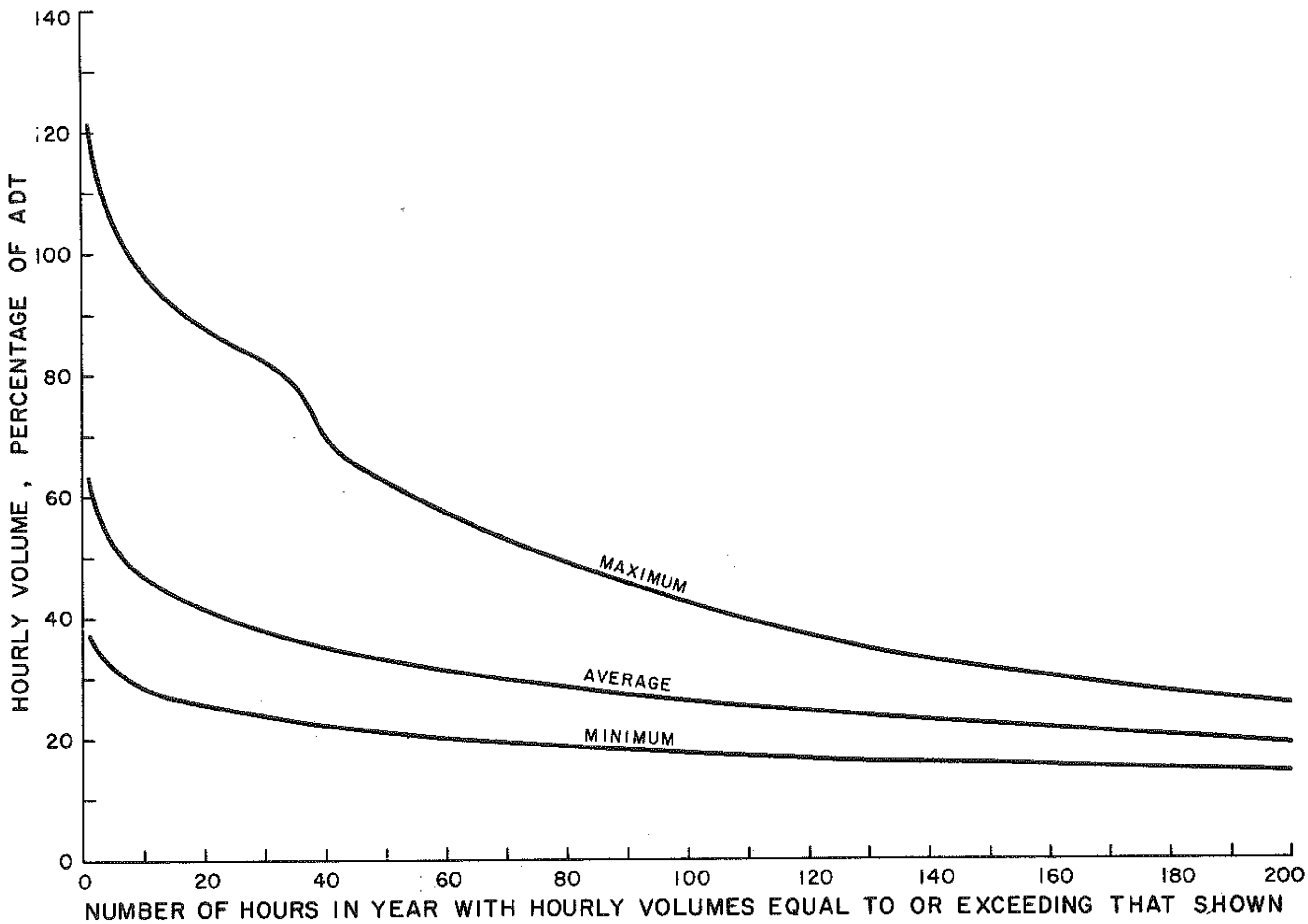

Figure 5. Highest Hourly Volumes.

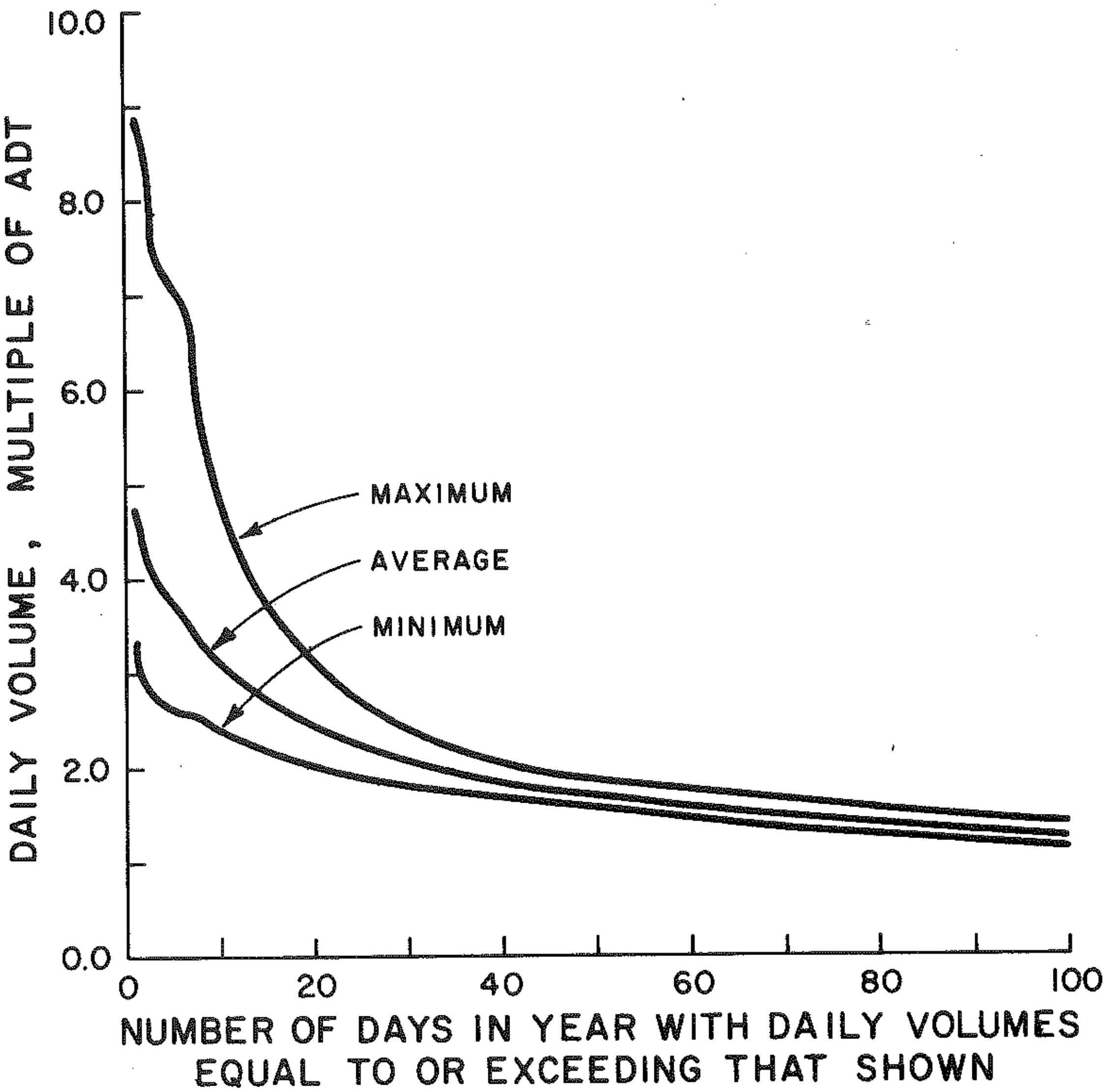

Figure 6. Highest Daily Volumes.

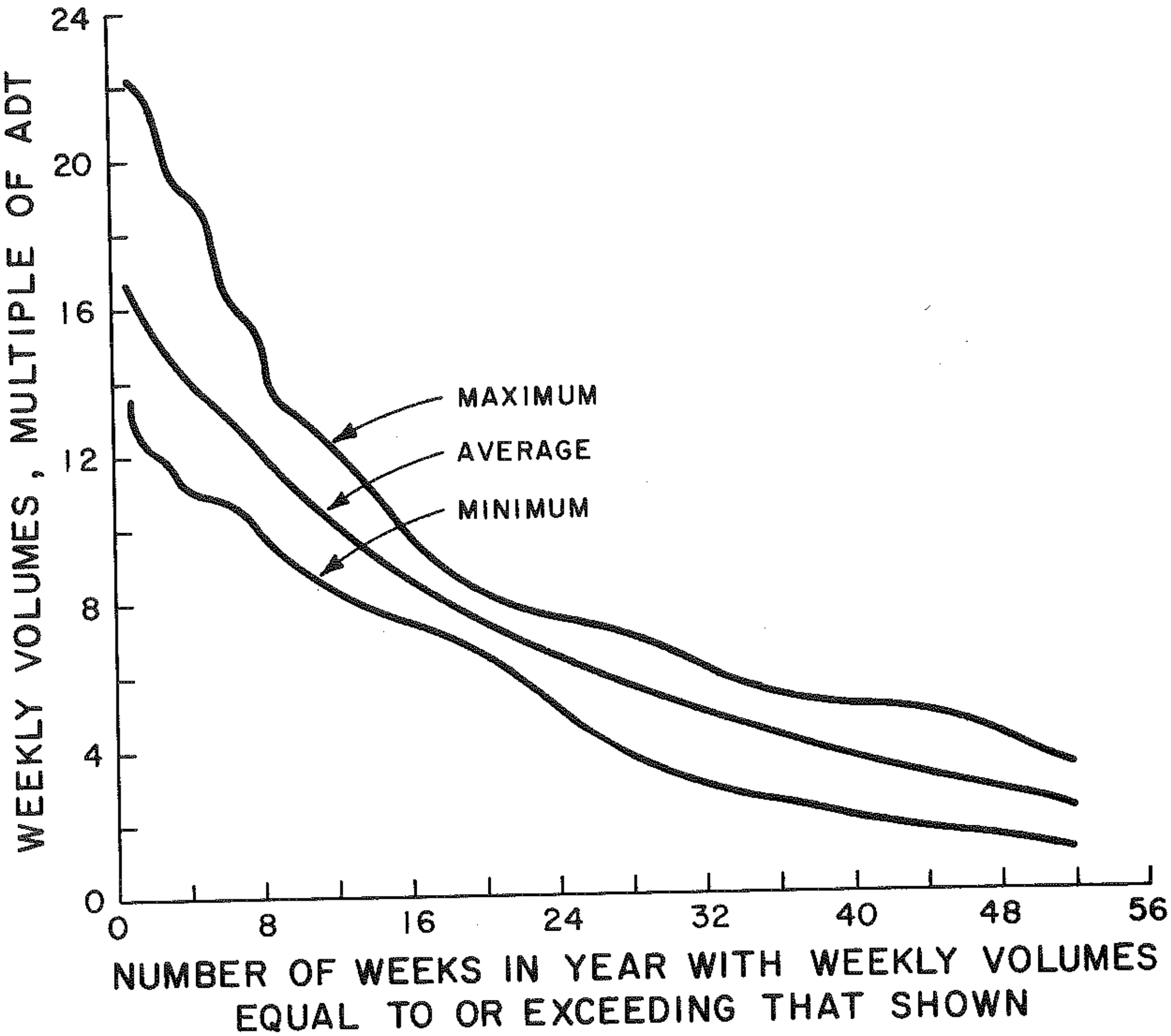

Figure 7. Highest Weekly Volumes.

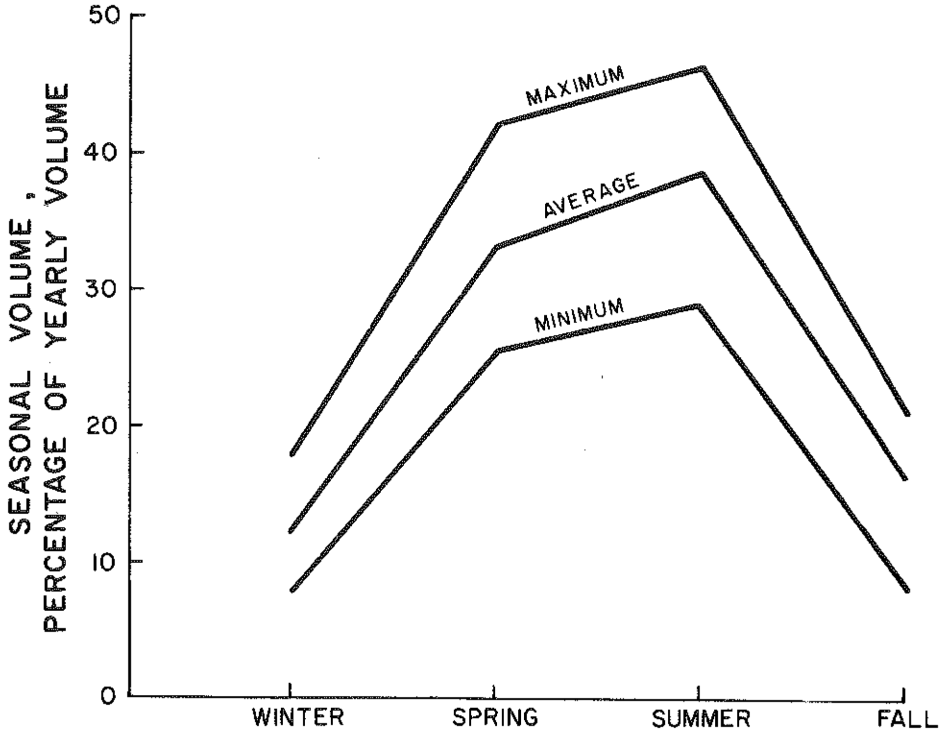

Figure 8. Volume Variation Among Seasons.

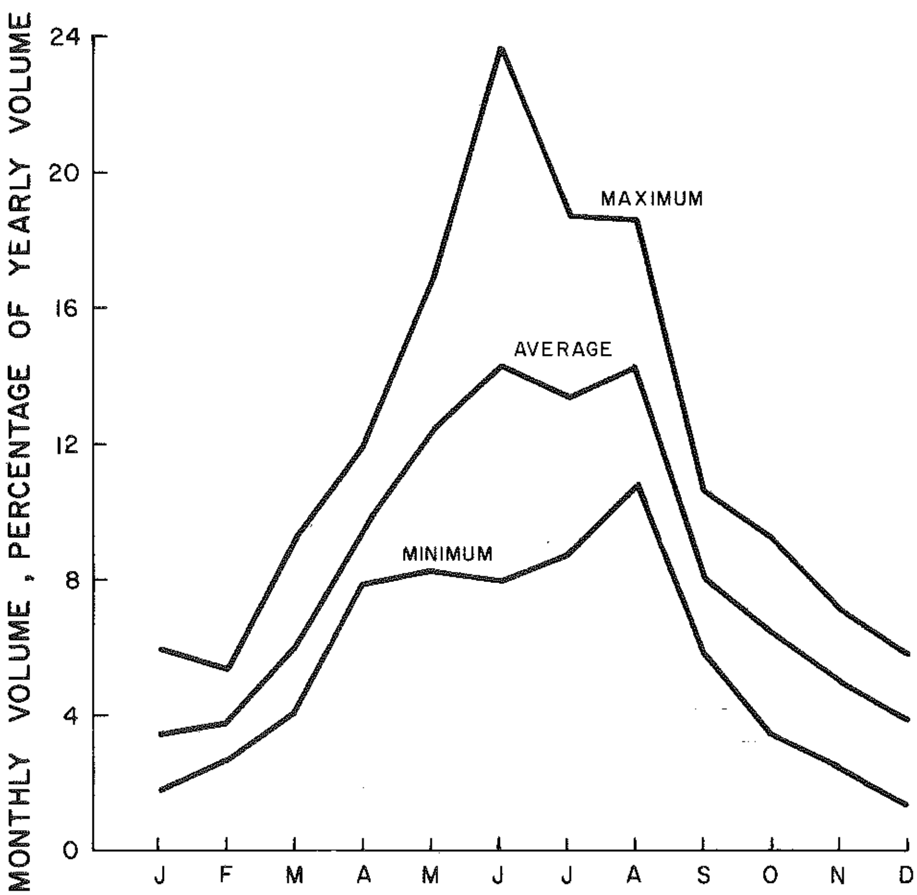

Figure 9. Volume Variation Among Months.

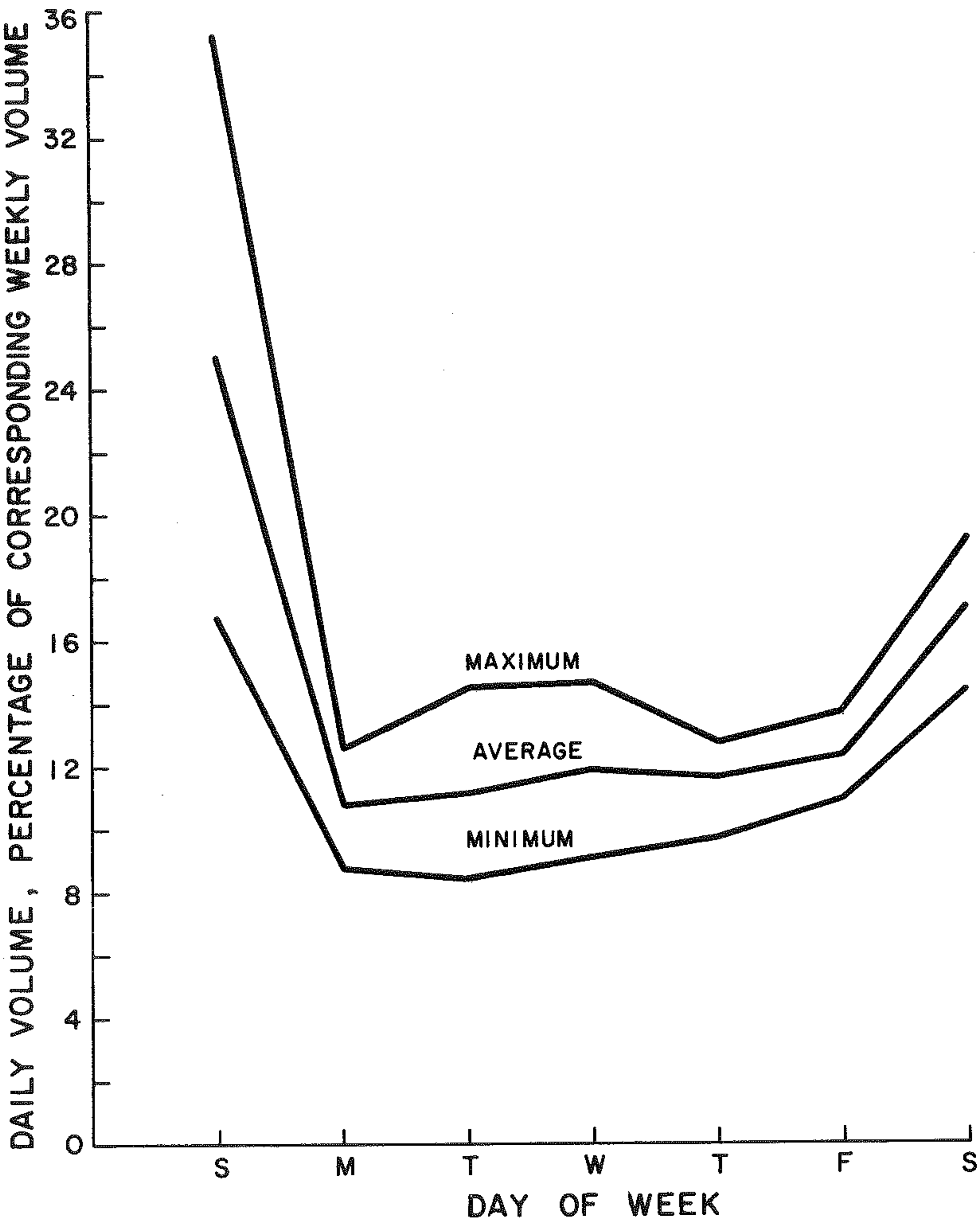

Figure 10. Volume Variation Among Days Throughout Average Summer Week.

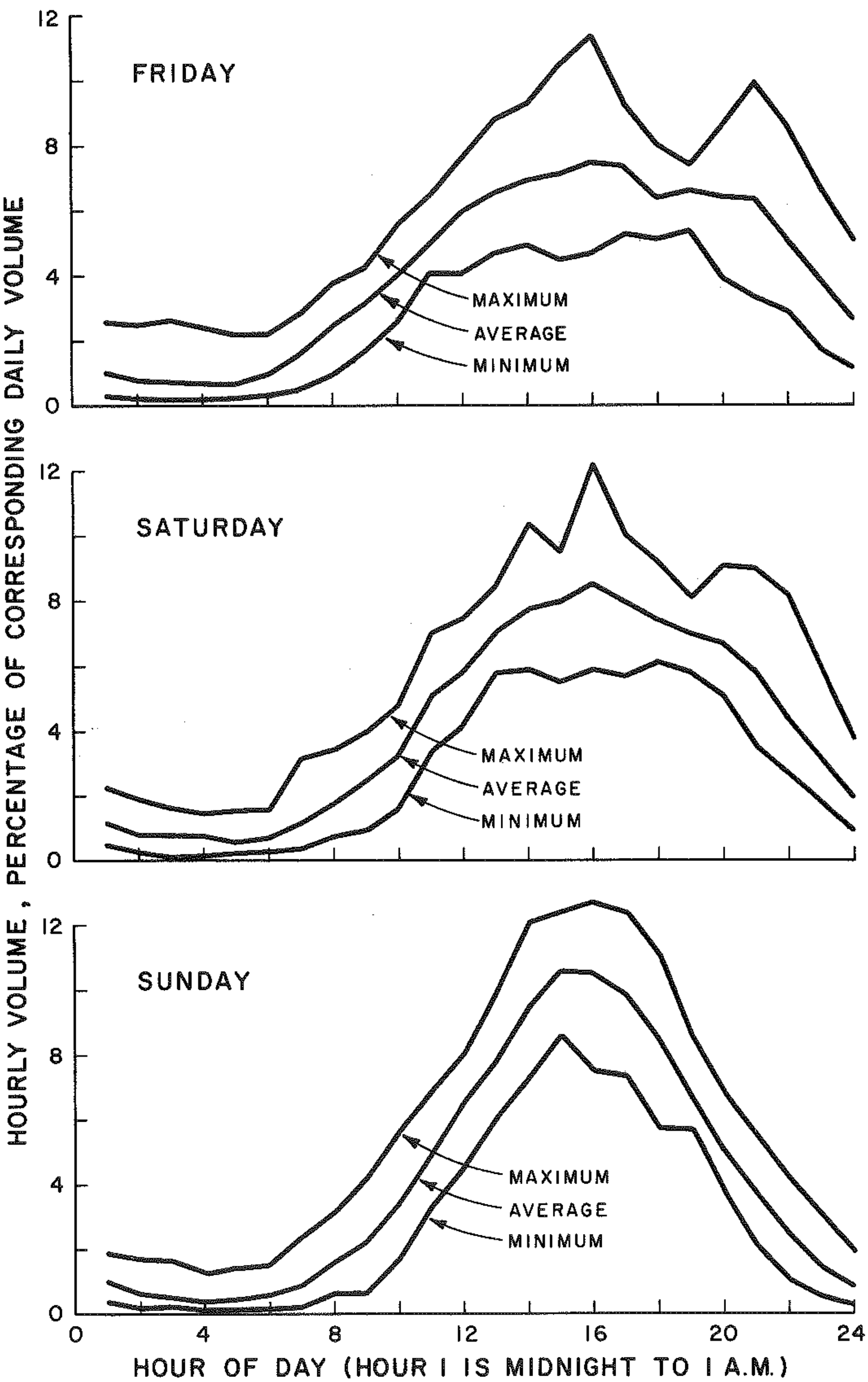

Figure 11. **Volume Variation Throughout Average Summer Weekend Days.**

TABLE 1

IDENTIFICATION OF RECREATIONAL AREAS

NUMBER[a]	AREA NAME	REGIONAL IMPACT	SCENIC ATTRACTIVENESS[b]	LAKE[c]	DAY-USE FACILITIES[d]	OVERNIGHT ACCOMODATIONS[e]	OTHER[f]
1	Columbus-Belmont S.P.	S	N	N	M	M	
2*	Kentucky Lake-Barkley Lake	L	H	L	L	L	G, OD, SP, SB
3	Lake Beshear-Pennyrile Forest	S	N	S	L	L	G, SP, SB
4	Audubon S.P.	S	N	S	L	M	G, SB
5	Lake Malone S.P.	S	N	L	L	M	SB
6*	Rough River Reservoir	S	N	L	L	L	G, SP, SB
7	Doe Valley Lake	S	N	S	S	S	SB
8	Otter Creek Park	S	N	N	L	L	SP
9	Nolin Reservoir	S	N	L	M	M	
10*	Mammoth Cave N.P.	L	P	N	M	L	
11	Shanty Hollow Lake	S	N	S	S	S	
12	Barren River Reservoir	S	N	L	L	L	G, SB
13	My Old Kentucky Home S.P.	M	P	N	L	M	G, OD
14	Green River Reservoir	S	N	L	M	S	
15	Dale Hollow Reservoir	M	N	L	M	M	SB
16	Lake Cumberland	M	N	L	L	L	G, SP, SB
17	Natural Arch and Rockcastle Areas	M	P	N	M	M	
18	Cumberland Falls S.P.	L	P	N	M	L	SP
19	Wilgreen Lake	S	N	S	S	S	
20	Herrington Lake	M	N	L	S	L	
21	Old Fort Harrod S.P.	L	P	N	M	S	OD
22*	Beaver Lake	S	N	S	S	S	
23	Guist Creek Lake	S	N	S	S	S	
24	General Butler S.P.	M	N	S	L	L	G, SP, SB
25	Elmer Davis Lake	S	N	S	S	S	
26	Lake Boltz	S	N	S	S	S	
27	Big Bone Lick S.P.	S	N	S	M	L	
28	Williamstown Lake	S	N	S	S	S	
29	Blue Licks Battlefield S.P.	M	H	N	M	S	SP
30*	Fort Boonesboro S.P.	M	H	N	M	M	SB
31*	Levi Jackson S.P.	S	N	N	L	L	SP
32	Pine Mountain S.P.	S	N	S	L	M	G, OD, SP
33	Cumberland Gap N.P.	L	P	N	L	L	OD
34	Natural Bridge S.P.	L	P	S	M	L	SP
35	Sky Bridge and Koomer Ridge	L	P	N	M	M	
36*	Carter Caves S.P.	M	H	S	L	S	G, SB
37	Greenbo Lakes S.P.	S	N	S	L	L	SB
38	Grayson Reservoir	S	N	L	M	S	
39	Buckhorn Lake	S	N	L	M	L	SB
40*	Jenny Wiley S.P.	S	N	L	L	L	G, OD, SP
41	Kingdom Come S.P.	S	N	S	M	S	
42	Fishtrap Reservoir	S	N	L	M	S	

[a] Asterisks indicate areas at which continuous traffic recorders were operated on major access roads.

[b] P, primary attractiveness is of a scenic or historic nature; H, high scenic or historic attractiveness with a balance of other recreational activities; N, normal scenic or historic attractiveness.

[c] L, Lake acreage $\geq$ 500; S, 0 $<$ lake acreage $<$ 500; N, no lake.

[d] L, availability of golf course and/or picnic tables $>$ 150; M, 0 $<$ picnic tables $\leq$ 150 and no golf course; S, no picnic tables and no golf course.

[e] L, units (cottages + lodge rooms + camping sites) $\geq$ 90; M, 15 $\leq$ units $<$ 90; S, units $<$ 15.

[f] G = golf; OD = outdoor drama; SP = swimming pool; SB = swimming beach.

TABLE 2

PERCENTAGE OF VEHICLES BY ORIGIN FOR DIFFERENT RECREATIONAL AREA TYPES

ORIGIN[a]	NATIONAL PARKS	LAND-BETWEEN-THE-LAKES (TVA)	DANIEL BOONE NATIONAL FOREST	STATE PARKS	KENTUCKY LAKE (TVA)	OTHER AREAS	CORPS OF ENGINEERS FACILITIES	ALL AREAS
Kentucky	36.57	54.05	67.95	70.67	72.08	81.44	85.21	73.02
East North Central States[b]	37.80	23.82	25.10	20.02	18.61	11.68	11.88	18.38
East South Central States[b]	8.14	15.72	1.16	2.69	3.20	1.08	0.82	2.76
South Atlantic States	7.75	1.39	1.28	3.11	1.34	2.17	0.98	2.55
Middle Atlantic States	4.06	0.61	0.78	0.63	0.52	1.11	0.17	0.64
West North Central States	1.76	2.58	0.52	1.74	3.37	0.84	0.42	1.49
West South Central States	1.70	1.48	0.65	0.51	0.63	0.41	0.26	0.53
New England States	0.63	0.09	0.39	0.11	0.03	0.42	0.06	0.12
Mountain States	0.25	0.05	0.26	0.12	0.13	0.29	0.04	0.13
Pacific States	0.77	0.21	0.13	0.29	0.07	0.48	0.08	0.25
Canada	0.52		0.25	0.10	0.02	0.08	0.01	0.09
Others	0.05	0.03	1.53	0.01			0.07	0.04

[a] U.S. Bureau of the Census Divisions

[b] Excluding Kentucky

TABLE 3

EFFECTS OF TYPE OF RECREATIONAL AREA AND LOCATION OF ORIGIN ON AVERAGE VEHICLE OCCUPANCY[a]

ORIGIN	STATE PARKS	NATIONAL PARKS	CORPS OF ENGINEERS FACILITIES	KENTUCKY LAKE (TVA)	LAND-BETWEEN-THE-LAKES (TVA)	DANIEL BOONE NATIONAL FOREST	OTHER AREAS	TOTAL
Kentucky	3.02	3.22	2.84	2.70	3.18	3.44	2.82	2.94
Ohio	3.47	3.37	3.11	3.69	3.61	3.33	3.00	3.37
Indiana	3.34	3.56	3.08	3.23	3.35	3.63	3.16	3.31
Illinois	3.68	3.57	3.43	3.39	3.54		3.38	3.57
Tennessee	3.40	3.29	3.13	3.39	3.23	3.43	3.82	3.32
Michigan	3.50	3.94	3.16	2.97	3.10	4.14	3.31	3.52
Missouri	3.61	3.44	3.14	3.03	3.32	6.00	2.33	3.40
W. Virginia	3.60	3.40	3.30	2.86	2.00	6.00	2.40	3.61
All Origins	3.13	3.36	2.88	2.87	3.26	3.41	2.87	3.06

[a]Persons per vehicle.

TABLE 4

EFFECTS OF DISTANCE AND VEHICLE TYPE ON AVERAGE VEHICLE OCCUPANCY

VEHICLE TYPE	DISTANCE INTERVAL (MILES)											AVERAGE (ALL DISTANCES)
	1-20	21-40	41-60	61-80	81-100	101-150	151-250	251-400	401-700	701-1300	1301-3000	
Car	2.78	3.02	3.28	3.27	3.31	3.29	3.20	3.45	3.39	3.25	3.11	3.07
Car with Boat and Trailer	3.02	3.14	3.12	3.25	3.13	3.15	3.45	3.19	3.16	3.18	3.60	3.16
Car with Boat on Top	2.72	3.14	3.05	2.79	3.00	3.09	3.92	3.31	3.00	2.50		3.04
Car with Camper Trailer	3.06	3.20	3.28	3.45	3.44	3.61	3.63	3.86	4.06	3.60	3.82	3.63
Single-Unit Camper	2.70	2.55	2.83	3.11	3.06	3.00	2.92	2.99	3.39	3.48	3.36	2.97
Single-Unit Camper with Boat	2.75	2.79	2.71	2.71	2.70	3.27	2.65	3.38	2.94	3.30	4.25	2.96
Other	2.16	1.61	1.92	2.19	5.30	1.63	1.69	4.78	1.57	1.75	20.50	2.67
Average (All Vehicles)	2.78	3.02	3.26	3.25	3.30	3.28	3.21	3.45	3.41	3.26	3.28	3.06

TABLE 5

EFFECT OF LOCATION OF ORIGIN ON PERCENTAGES OF VARIOUS VEHICLE TYPES

ORIGIN	CAR	CAR WITH BOAT AND TRAILER	CAR WITH BOAT ON TOP	CAR WITH CAMPER TRAILER	SINGLE UNIT CAMPER	SINGLE UNIT CAMPER WITH BOAT	OTHER
Kentucky	90.89	5.27	.40	.61	1.08	.37	1.38
Ohio	86.46	5.34	.63	3.35	2.62	62	.97
Indiana	87.57	4.51	.62	2.38	3.15	.87	.90
Illinois	88.11	3.36	.88	3.20	2.72	.86	.88
Tennessee	90.99	3.44	.32	1.59	1.62	1.05	.99
Michigan	85.74	2.28	.70	6.08	3.33	.94	.94
Missouri	88.67	4.03	.77	2.82	2.63	.51	.58
W. Virginia	88.51	2.31	.79	5.61	1.45	.46	.86
All Origins	89.95	4.91	.46	1.36	1.58	.48	1.26

TABLE 6

EFFECT OF TYPE OF RECREATIONAL AREA ON PERCENTAGES OF VARIOUS VEHICLE TYPES

TYPE OF FACILITY	PERCENTAGE OF CARS[a]	PERCENTAGE OF CAMPING VEHICLES[b]	PERCENTAGE OF VEHICLES WITH BOATS
State Parks	97.36	2.95	3.22
National Parks	95.56	6.51	0.58
Corps of Engineers Facilities	95.71	3.29	12.31
Kentucky Lake (TVA)	96.31	3.81	6.14
Land-Between-The-Lakes (TVA)	90.84	11.24	12.02
Daniel Boone National Forest	96.22	2.99	3.25
Other Areas	97.84	2.59	7.15
All Areas	96.67	3.42	5.84

[a]Includes cars with boat and camper trailers.

[b]Includes cars with camper trailers and single-unit campers.

TABLE 7

AVERAGE AND HIGHEST VOLUMES

TIME PERIOD	TYPE OF VOLUME	VOLUME EXPRESSED AS MULTIPLE OF AVERAGE DAILY TRAFFIC								
		AREA 2	AREA 6	AREA 10	AREA 22	AREA 30	AREA 31	AREA 36	AREA 40	AVERAGE
Week	Maximum	14.3	19.1	17.6	13.4	22.2	15.6	14.7	15.6	16.6
Week	4th Highest	13.0	17.1	14.5	10.9	19.0	12.2	13.4	12.8	14.1
Week	8th Highest	11.3	14.0	13.1	10.5	15.2	11.1	12.1	9.8	12.1
Week	Summer Average	8.3	12.3	13.0	8.0	11.7	10.9	11.4	10.8	10.8
Weekend	Maximum	6.62	11.71	6.26	6.15	14.77	7.10	9.56	6.82	8.62
Weekend	4th Highest	5.54	9.89	5.64	5.31	11.28	5.52	6.43	5.75	6.92
Weekend	8th Highest	4.66	7.64	4.36	4.51	8.04	5.07	5.70	4.61	5.57
Weekend	Summer Average	3.53	6.28	4.43	3.30	6.14	4.94	5.24	4.81	4.83
Weekend	Annual Average	2.99	3.49	2.64	3.00	3.93	3.25	3.34	3.06	3.21
Day	Maximum	3.72	6.61	3.50	3.32	8.89	3.47	5.00	3.68	4.77
Day	5th Highest	2.91	5.50	2.73	2.60	7.06	2.93	3.69	2.84	3.78
Day	10th Highest	2.39	4.08	2.58	2.42	5.03	2.58	3.02	2.47	3.07
Day	20th Highest	2.13	2.92	2.34	2.00	3.08	2.11	2.46	2.15	2.40
Day	Summer Sunday Average	2.18	3.66	2.18	1.56	4.12	2.54	2.98	2.53	2.72
Hour	Maximum	0.430	0.839	0.372	0.496	1.212	0.612	0.674	0.425	0.632
Hour	15th Highest	0.350	0.602	0.264	0.273	0.912	0.310	0.428	0.353	0.436
Hour	30th Highest	0.303	0.503	0.254	0.240	0.829	0.284	0.395	0.294	0.388
Hour	50th Highest	0.279	0.410	0.242	0.213	0.627	0.262	0.367	0.253	0.332
Hour	100th Highest	0.243	0.321	0.222	0.176	0.404	0.217	0.292	0.214	0.261

TABLE 8

PEAK VOLUMES FOR SEASON OF YEAR, MONTH OF YEAR, AND DAY OF AVERAGE SUMMER WEEK

AREA	PERIOD OF PEAK VOLUME			PEAK VOLUME		
	DAY OF SUMMER WEEK	MONTH OF YEAR	SEASON OF YEAR	DAY (PERCENT OF AVERAGE SUMMER WEEK)	MONTH (PERCENT OF ANNUAL VOLUME)	SEASON (PERCENT OF ANNUAL VOLUME)
2	Sunday	May	Spring	26.46	16.92	38.55
6	Sunday	June	Summer	29.83	19.44	43.84
10	Sunday	August	Summer	16.82	18.51	46.41
22	Sunday	May	Spring	19.41	14.67	36.00
30	Sunday	June	Spring	35.26	23.66	42.16
31	Sunday	August	Summer	23.19	15.64	39.06
36	Sunday	August	Summer	26.30	15.39	40.54
40	Sunday	August	Summer	23.50	16.50	38.52
Average				25.09	17.59	40.64

TABLE 9

PEAK-HOUR VOLUMES FOR AVERAGE SUMMER FRIDAYS, SATURDAYS, AND SUNDAYS

AREA	HOUR OF PEAK VOLUME			PEAK HOURLY VOLUME (PERCENT OF DAILY VOLUME)		
	FRIDAY	SATURDAY	SUNDAY	FRIDAY	SATURDAY	SUNDAY
2	3-4 p.m.	3-4 p.m.	3-4 p.m.	11.41	12.17	12.68
6	8-9 p.m.	2-3 p.m.	3-4 p.m.	7.75	8.85	11.14
10	4-5 p.m.	4-5 p.m.	3-4 p.m.	8.44	8.94	9.83
22	7-8 p.m.	3-4 p.m.	2-3 p.m.	6.44	7.06	8.59
30	2-3 p.m.	3-4 p.m.	4-5 p.m.	8.37	10.05	12.39
31	8-9 p.m.	7-8 p.m.	2-3 p.m.	9.90	9.11	11.31
36	4-5 p.m.	2-3 p.m.	1-2 p.m.	7.53	9.20	12.11
40	4-5 p.m.	3-4 p.m.	1-2 p.m.	8.28	7.88	9.72
Average				8.52	9.16	10.97

TABLE 10

EXPANSION FACTORS FOR SUMMER SHORT-TERM COUNTS

COUNTING PERIOD	AREA								
	2	6	10	22	30	31	36	40	AVERAGE
				To Convert Short-Term Count To Average Daily Traffic					
Sunday	0.464	0.292	0.450	0.653	0.255	0.401	0.345	0.388	0.406
Monday	1.049	0.933	0.635	1.067	0.950	0.826	0.861	0.826	0.893
Tuesday	1.056	0.818	0.529	1.097	1.020	0.742	0.873	0.831	0.871
Wednesday	0.950	0.796	0.523	0.928	0.939	0.800	0.753	0.798	0.811
Thursday	1.022	0.786	0.605	0.990	0.883	0.751	0.755	0.790	0.724
Friday	1.070	0.701	0.562	0.971	0.779	0.724	0.705	0.710	0.778
Saturday	0.868	0.446	0.491	0.690	0.516	0.541	0.496	0.509	0.570
Weekend	0.284	0.162	0.219	0.313	0.162	0.206	0.190	0.209	0.218
10-hour Sunday	0.527	0.353	0.564	1.013	0.291	0.520	0.403	0.517	0.524
Week	0.121	0.084	0.075	0.118	0.088	0.087	0.085	0.088	0.093
				To Convert Short-Term Count To Average Summer Sunday Traffic					
Sunday	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000
Monday	2.259	3.196	1.411	1.636	3.729	2.061	2.494	2.130	2.364
Tuesday	2.275	2.803	1.175	1.681	4.004	1.851	2.527	2.141	2.307
Wednesday	2.047	2.727	1.161	1.423	3.686	1.996	2.181	2.058	2.160
Thursday	2.202	2.692	1.344	1.517	3.468	1.875	2.188	2.037	2.165
Friday	2.304	2.401	1.248	1.488	3.061	1.806	2.042	1.830	2.022
Saturday	1.869	1.529	1.090	1.058	2.026	1.350	1.436	1.311	1.459
Weekend	0.611	0.556	0.487	0.480	0.636	0.513	0.549	0.539	0.546
10-hour Sunday	1.134	1.210	1.252	1.552	1.142	1.297	1.167	1.332	1.261
Week	0.260	0.289	0.166	0.181	0.346	0.217	0.247	0.228	0.242